Identification of travelling ionospheric disturbances in the ionosphere using GPS with independent verification

K.H.A. Bolmgren[(1)]*, C.N. Mitchell [(1)], J. Bruno[(1)] and G.S. Bust[(2)]
(1) Department of Electronic and Electrical Engineering, University of Bath, Bath, UK
(2) Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA

Extended Abstract

Travelling ionospheric disturbances (TIDs) cause wave-like oscillations in ionospheric electron density. Currently, the vast majority of available observations of the ionosphere come from global positioning satellite systems such as GPS. However, the long integration paths through the ionosphere, the movement of the satellites and the use of simplistic filtering techniques brings into question the reliable identification of fast moving structures such as medium-scale TIDs. The ionosphere can be imaged in three spatial dimensions with GPS tomography using algorithms such as MIDAS (multi-instrument-data-analysis-system). Small scale features can be difficult to resolve using GPS tomography, and different methods have been applied to image larger TIDs [1]. This paper takes a comprehensive approach to determining the capability and limitations of using GPS signals for studying TIDs by modelling how different TID characteristics affect the tomographic reconstruction. The TIDs are modelled as relative changes in electron density caused by internal atmospheric gravity waves propagating at ionospheric heights, based on the work by Hooke [2]. These are applied to a slowly varying background electron density and reconstructed using GPS tomography for selected sets of gravity wave parameters spanning medium- to large-scale TIDs. The results show the strengths, limitations, blurring and artefacts and the advantage of including measurements from a geostationary satellite. In the final step, actual data taken through a TID rich ionosphere are analysed to investigate the applicability of the study to real-world observations. The results show promise for the identification of some TIDs using GPS and show the key importance of backing up the observations with computer modelling to test the techniques being used. The implications for the resolution of ionospheric data assimilation algorithms and in particular the use of different observations to infer the presence of TIDs are discussed.

References

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